Experimental investigation of NAPL migration and source zone formation in saturated heterogeneous media

Fritjof Fagerlund[1]
(1) PhD-student, Air- and Water Sciences, Department of Earth Sciences, Uppsala University, Uppsala, Sweden
(2) Center for Experimental Study of Subsurface Environmental Processes (CESEP), Department of Environmental Science and Engineering, Colorado School of Mines, Golden, CO

Tissa Illangasekare
Center for Experimental Study of Subsurface Environmental Processes (CESEP), Department of Environmental Science and Engineering, Colorado School of Mines, Golden, Colorado

Auli Niemi
Air- and Water Sciences, Department of Earth Sciences, Uppsala University, Uppsala, Sweden

Abstract. The combination of high density and low viscosity of several common DNAPLs allows these contaminants to penetrate deep into the saturated zone where a complex entrapment architecture generally is formed. The longevity of the resulting groundwater contamination by dissolved constituents as well as the success of remediation attempts are highly dependent on the DNAPL source zone characteristics.

In a two-dimensional, intermediate-size, flume study, the effect of an inclined interface between two permeable units as well as the effects of heterogeneities within each unit, on the migration and source zone formation of NAPLs in the saturated zone has been investigated.

The use of a multiple energy source x-ray attenuation system allows accurate measurements of water and NAPL saturations as well as porosity. While the NAPL is moving the dynamic system is also monitored by taking digital images of the colored NAPL plume which are combined with x-ray measurements. To minimize hazardous waste production the use of toxic DNAPLs has been avoided. This is obtained by studying an equivalent system where an LNAPL (soltrol 220), driven by a net buoyancy force, is migrating upwards.

Preliminary results show that at smooth interfaces between homogeneous layers, NAPL pool-depths are not likely to be large enough to produce pressures that exceed the entry-pressure of a second, less permeable formation. Thus the pool migrates along the interface without penetrating into the second formation. For the more realistic heterogeneous case, larger pool depths may develop as a result of heterogeneities along the interface and penetration into the second layer is more likely.

1 Center for Experimental Study of Subsurface Environmental Processes (CESEP)
Department of Environmental Science and Engineering, Colorado School of Mines
Golden, CO 80401 - 1887
Tel: (303) 273-3483
e-mail: Fritjof.Fagerlund@hyd.uu.se